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09/914631

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

CHASKIN, Jay, L.
General Electric Company
3135 Easton Turnpike W3C
Fairfield, CT 06431
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 30 August 2001 (30.08.01)	
Applicant's or agent's file reference 16NM99181	**IMPORTANT NOTIFICATION**
International application No. PCT/US01/03311	International filing date (day/month/year) 01 February 2001 (01.02.01)
International publication date (day/month/year) 09 August 2001 (09.08.01)	Priority date (day/month/year) 04 February 2000 (04.02.00)
Applicant GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY LLC. et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
04 Febr 2000 (04.02.00)	2000-27652	JP	16 July 2001 (16.07.01)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Gabriele BAEHR

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

INVITATION TO PAY ADDITIONAL FEES

(PCT Article 17(3)(a) and Rule 40.1)

To:
GENERAL ELECTRIC COMPANY
Attn. Chaskin, Jay L.
3135 Easton Turnpike W3C
Fairfield, CT 06431
UNITED STATES OF AMERICA

RECEIVED
JUN 22 2001
IPO
GENERAL ELECTRIC CO

	Date of mailing *(day/month/year)* 18/06/2001
Applicant's or agent's file reference 16NM99181	**PAYMENT DUE** within 45 ~~months~~/days from the above date of mailing
International application No. PCT/US 01/03311	International filing date *(day/month/year)* 01/02/2001

Applicant

GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY LLC.

1. This International Searching Authority

(i) considers that there are 2 *(number of)* inventions claimed in the international application covered by the claims indicated ~~below~~/on the extra sheet:

and it considers that the international application does not comply with the requirements of unity of invention (Rules 13.1, 13.2 and 13.3) for the reasons indicated ~~below~~/on the extra sheet:

ACTION DUE 8-02-2001

ATTORNEY JLC

LOGGED BY RC 6-25-01

(ii) [X] has carried out a partial international search (see Annex) [ ] will establish the international search report on those parts of the international application which relate to the invention first mentioned in claims Nos.:
1-3

(iii) will establish the international search report on the other parts of the international application only if, and to the extent to which, additional fees are paid

2. The applicant is hereby **invited,** within the time limit indicated above, to pay the amount indicated below:

EUR 945,00 x 1 = EUR 945,00
Fee per additional invention | number of additional inventions | total amount of additional fees

Or, _____ x _____ = _____

The applicant is informed that, according to Rule 40.2(c), **the payment of any additional fee may be made under protest,** i.e., a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fee is excessive.

3. [ ] Claim(s) Nos. _____ have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Luis-Miguel Paredes Sanchez

Form PCT/ISA/206 (July 1992)

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US 01/03311

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
1-3
2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 983 715 A (HAIR JR JOHN E ET AL) 5 October 1976 (1976-10-05)	1,2
Y	column 3, line 49 - line 57 column 4, line 47 - line 51 column 5, line 9 - line 32	3
Y	DE 35 28 821 A (BOSCH GMBH ROBERT) 12 February 1987 (1987-02-12) abstract	3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Pat nt Family Annex

Information on patent family members

International Application No
PCT/US 01/03311

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3983715 A	05-10-1976	BR 7600743 A	31-08-1976
		CA 1030761 A	09-05-1978
		IL 48875 A	29-09-1978
		JP 51104740 A	16-09-1976
		ZA 7600139 A	29-12-1976
DE 3528821 A	12-02-1987	NONE	

INVITATION TO PAY ADDITIONAL FEES

International application No.
PCT/US 01/03311

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-3

   Air feed device provided with fluid flow adjustment means.

2. Claims: 4-15

   Air feed device included in a signal acquisition device.

US 3983715 discloses a blade-type fan driven by a hydraulic motor wherein the flow rate of the hydraulic pump can be adjusted. The fan moves air into a compartment occupied by a person.

1) Compared to this document, claims 1 and 2 are not new. Concerning the first group of claims (1 to 3) a special technical feature which can be defined, if any, could be the presence of means for adjusting the ratio of fluid flow quantity supplied to the fluid motor to fluid flow quantity bypassing the fluid motor.

2) In the second group of claims (4 to 15), a special technical feature with reference to the prior art could be the inclusion of the fluid motor and of the air feed device in a signal acquisition means.

These special technical features have nothing in common since they specify characteristics of different nature.

The two inventions also solve different problems, namely:

1) Perform air flow rate adjustment (cfr. page 13, lines 22 and 23).

2) Perform diagnostic imaging of a subject.

Since the special technical features of the two groups of inventions are not the same and solve different problems, no same or corresponding special technical feature can be defined between the inventions. The requirement of unity of the invention (PCT rule 13.1) is not fulfilled.

09/914631

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 August 2001 (09.08.2001)

PCT

(10) International Publication Number
WO 01/56493 A3

(51) International Patent Classification[7]: A61B 5/055

(21) International Application Number: PCT/US01/03311

(22) International Filing Date: 1 February 2001 (01.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000-27652 4 February 2000 (04.02.2000) JP

(71) Applicant *(for all designated States except US)*: **GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY LLC.** [US/US]; 3000 North Grandview Boulevard-W-710, Waukesha, WI 53188 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **KAN, Koji** [JP/JP]; 7-127, Asahigaoka 4-chome, Hino-shi, Tokyo 191-8503 (JP).

(74) Agents: **CHASKIN, Jay, L.** et al.; General Electric Company, 3135 Easton Turnpike W3C, Fairfield, CT 06431 (US).

(81) Designated States *(national)*: CN, KR, US.

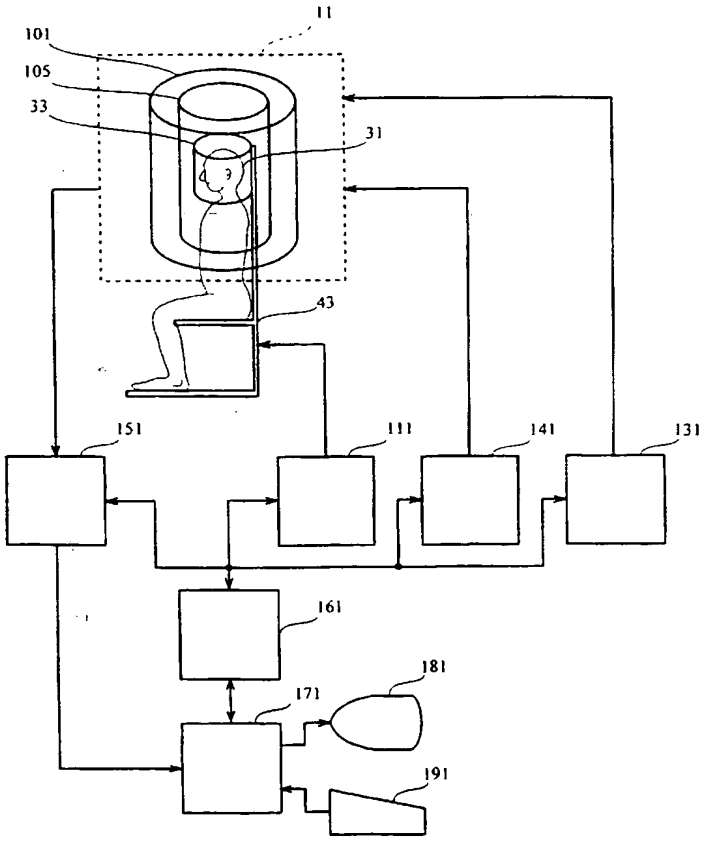
(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *with international search report*

(88) Date of publication of the international search report:
14 March 2002

[Continued on next page]

(54) Title: AIR FEED DEVICE, SIGNAL ACQUISITION DEVICE AND IMAGING DEVICE



(57) Abstract: An air feed device comprised of a fluid motor to drive rotating vanes and blow air with high efficiency into a space accommodating a subject.

WO 01/56493 A3

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

09914.631

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
16NM99181		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 01/03311	01/02/2001	04/02/2000

Applicant

GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY LLC.

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readble form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☒ **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ None of the figures.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 01/03311

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-3

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-3

   Air feed device provided with fluid flow adjustment means.

2. Claims: 4-15

   Air feed device included in a signal acquisition device.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]T/US 01/03311

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/055

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 983 715 A (HAIR JR JOHN E ET AL) 5 October 1976 (1976-10-05)	1,2
Y	column 3, line 49 - line 57 column 4, line 47 - line 51 column 5, line 9 - line 32 ---	3
Y	DE 35 28 821 A (BOSCH GMBH ROBERT) 12 February 1987 (1987-02-12) abstract -----	3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 June 2001	02. 11. 01

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Martelli, L

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

ation on patent family members

International Application No
[redacted]T/US 01/03311

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3983715 A	05-10-1976	BR 7600743 A	31-08-1976
		CA 1030761 A1	09-05-1978
		IL 48875 A	29-09-1978
		JP 51104740 A	16-09-1976
		ZA 7600139 A	29-12-1976
DE 3528821 A	12-02-1987	DE 3528821 A1	12-02-1987

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 August 2001 (09.08.2001)

PCT

(10) International Publication Number
WO 01/56493 A2

(51) International Patent Classification[7]: A61B 50/55

(21) International Application Number: PCT/US01/03311

(22) International Filing Date: 1 February 2001 (01.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2000-27652 4 February 2000 (04.02.2000) JP

(71) Applicant *(for all designated States except US)*: **GE MEDICAL SYSTEMS GLOBAL TECHNOLOGY COMPANY LLC.** [US/US]; 3000 North Grandview Boulevard-W-710, Waukesha, WI 53188 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **KAN, Koji** [JP/JP]; 7-127, Asahigaoka 4-chome, Hino-shi, Tokyo 191-8503 (JP).

(74) Agents: **CHASKIN, Jay, L.** et al.; General Electric Company, 3135 Easton Turnpike W3C, Fairfield, CT 06431 (US).

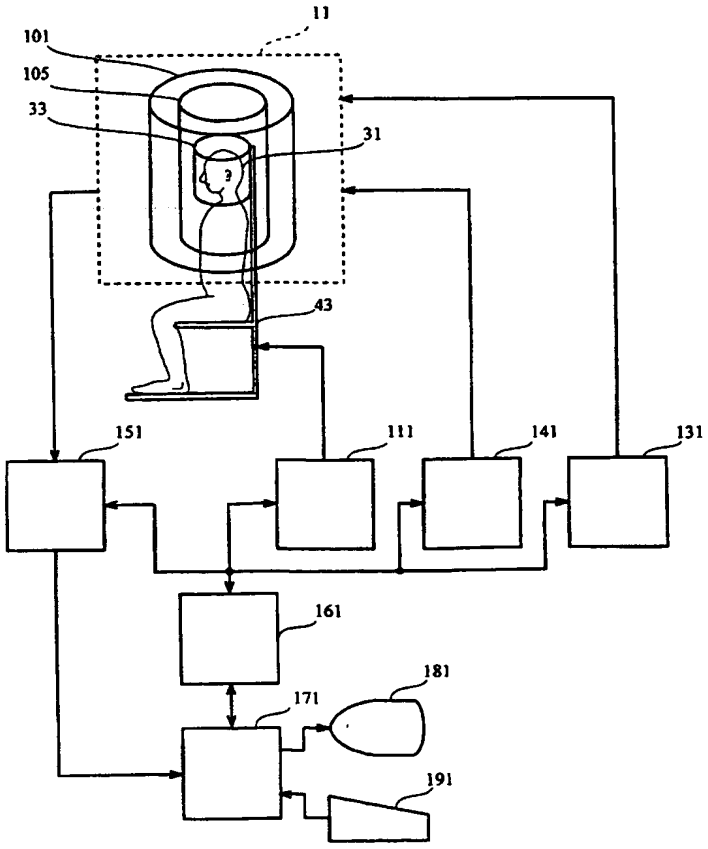
(81) Designated States *(national)*: CN, KR, US.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AIR FEED DEVICE, SIGNAL ACQUISITION DEVICE AND IMAGING DEVICE



(57) Abstract: An air feed device comprised of a fluid motor to drive rotating vanes and blow air with high efficiency into a space accommodating a subject.

WO 01/56493 A2

AIR FEED DEVICE, SIGNAL ACQUISITION DEVICE AND IMAGING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to an air feed device, a signal acquisition device, and an imaging device, and relates in particular to a device for feeding an air blow to a space for storing the subject for measurement, a signal acquisition device, and an imaging device comprised of such an air feed device.

In a magnetic resonance imaging device, the subject for imaging is loaded into an inner space of the magnet system, or in other words into an image capture space formed of a static magnetic field, a gradient magnetic field and a high frequency magnetic field applied to generate a magnetic resonance signal within the imaging subject, and a cross sectional image is generated (reconstructed) based on that received signal.

An air blow (or breeze) is fed into the image capture space to provide a cool feeling to the subject for imaging. The air or breeze is blown to the image capture space from an air duct by an electric air blower installed at a location well separated from image capture space, so that the electric air blower does not electrically interfere with the magnetic resonance signal.

The above air feed device had poor efficiency because of energy losses in the air duct.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an air feed device of high efficiency, a signal acquisition device comprised of such an air feed device, and an imaging device.

(1) A first aspect of the invention for solving the above mentioned problems is characterized in being comprised of a fluid motor rotatably driven by the flow of fluid, and a rotating vane to force air into a space holding the subject for imaging.

In this aspect of the invention, rotating vanes generate an air blow (or breeze) by utilizing a fluid motor as a motive source. The fluid motor does not generate electrical interference signals and so can bring about an air blow (or breeze) near the imaging subject, and can blow the air with high efficiency.

(2) A second aspect of the invention for solving the above mentioned problems is characterized in being comprised of a signal acquisition means having a space to store the signal acquisition object, a fluid motor rotatably driven by the flow of fluid, a rotating vane driven by the fluid motor to generate an air blow in the space, and a rotation transmission means to transmit the rotation of the vanes.

In this aspect of the invention, the rotating vanes generate a breeze utilizing the fluid motor as a motive source. The fluid motor does not generate electrical interference signals and can therefore generate a breeze

near the signal acquisition subject, and blow the air with high efficiency.

(3) A third aspect of the invention for solving the above problems is characterized in that the signal acquisition device according to the second aspect of the invention includes a signal acquisition means having a section to be cooled by the fluid, and the fluid motor is driven by fluid to cool the section to be cooled.

In this aspect of the invention, the fluid for cooling in the signal acquisition means rotates the fluid motor so that a simple structure combining the cooling system and fluid motor drive system can be achieved.

(4) A fourth aspect of the invention for solving the above problems is characterized in that the imaging device is comprised of an imaging means having a space to store the imaging subject, a fluid motor rotatably driven by the flow of fluid, and rotating vanes driven by the motor to force air into the space storing the imaging subject.

In this aspect of the invention, the rotating vanes generate a breeze utilizing the fluid motor as a motive source. The fluid motor does not generate electrical interference signals and can therefore generate a breeze near the signal acquisition subject, and blow the air with high efficiency.

(5) A fifth aspect of the invention for solving the above problems is characterized in that the imaging according to the fourth aspect of the invention includes a signal acquisition means having a section to be cooled

by the fluid, and the fluid motor is driven by fluid to cool the section to be cooled.

In this aspect of the invention, the fluid for cooling in the imaging means rotates the fluid motor so that a simple structure combining the cooling system and fluid motor drive system can be achieved.

Therefore, this invention provides a highly efficient air feed device, as well as a signal acquisition device and imaging device comprised of the air feed device.

Further objects and advantages of the present invention will be apparent from the following description of the preferred embodiments of the inventions as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the device of the embodiment of this invention.

FIG. 2 is a perspective view of the external appearance of the magnet system of the device shown in FIG. 1 along with the imaging subject in standby state.

FIG. 3 is a side view of the external appearance of the magnet system of the device shown in FIG. 1 along with imaging subject in standby state and the operator.

FIG. 4 is a perspective view of the external appearance of the magnet system of the device shown in FIG. 1 along with imaging subject during the imaging

operation.

FIG. 5 is a drawing showing the interrelation of the magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 6 is a drawing showing the interrelation of the magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 7 is a drawing showing the interrelation of the magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 8 is a drawing showing the interrelation of the magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 9 is a drawing showing the interrelation of the magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 10 is a drawing showing a typical pulse sequence implemented by the device shown in FIG. 1.

FIG. 11 is a drawing showing a typical pulse sequence implemented by the device shown in FIG. 1.

FIG. 12 is a drawing showing the interrelation of the horizontal bore magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 13 is a drawing showing the interrelation of the horizontal bore magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 14 is a drawing showing the interrelation of the horizontal bore magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 15 is a drawing showing the interrelation of the horizontal bore magnet system, the air feed device, and the imaging subject during the imaging operation.

FIG. 16 is a drawing showing the interrelation of the horizontal bore magnet system, the air feed device, and the imaging subject during the imaging operation.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The preferred embodiments of the invention are hereafter explained while referring to the accompanying drawings. A block diagram of the magnetic resonance imaging device is shown in FIG. 1. This device is an embodiment of the invention. An example of the embodiment of the invention is shown by means of the structure of this device.

The device as shown in FIG. 1 has a magnet system 11. The magnet system 11 has a main magnetic field coil unit 101 and a gradient coil unit 105. Each of these coils has a generally cylindrical shape and are arranged mutually concentric to each other. The bore of the magnet system 11 faces perpendicularly and so this system is called a vertical bore magnet system.

Though not shown in the drawing, the magnet system 11 is comprised of an air blow device to supply a breeze (air blow) to an internal space. This air feed device is

described again later on.

A testee 31 is seated on a seat 43 and carried in to the generally columnar inner space of the magnet system 11. The center axis of the generally columnar inner space faces perpendicularly. The shape of the internal space is not limited to a columnar shape but may also be a pillar shaped inner space having a lateral cross section of an appropriate shape. The testee 31 takes an upright posture by sitting in the sear 43. The seat 43 occupied by the testee 31 is driven to advance and retract vertically by a seat drive section 111.

The head of the testee 31 is held inside the RF (radio frequency) coil 33 installed above the back of the seat 43. The RF coil 33 is comprised for example, of a TEM (transverse electromagnetic mode) resonator type RF coil. The RF coil 33 also has a generally cylindrical shape and is installed in the inner space of the magnet system 11 along the same axis as the main magnetic field coil unit 101 and a gradient coil unit 105.

The main magnetic field coil unit 101 forms a static magnetic field in the inner space (bore) of the magnet system 11. The main magnetic field coil unit 101 is formed by utilizing for example, a super-conductive coil. Of course, this invention is not limited to use of a super-conductive coil and may use an ordinary conductive coil.

The gradient coil unit 105 generates a gradient magnetic field for making the static magnetic field intensity have a gradient. The generated gradient magnetic field is of three types: a slice gradient field,

a readout gradient field and a phase encode gradient magnetic field. The gradient coil unit 105 has a three-system gradient coil (not shown in the drawing) for these three types of gradient magnetic fields.

The RF coil 33 configures a high frequency magnetic field for excitation a spin within the body of the testee 31 in the static magnetic field space. The forming of the high frequency magnetic field is referred to as transmission of the RF excitation signal. The transmission of the RF excitation signal may also be performed by a dedicated transmission RF coil separate from the RF coil 33. The RF coil 33 receives the magnetic waves generated by the excited spin or in other words the magnetic resonance signal.

The gradient coil unit 131 applies a drive signal to the gradient coil unit 105 and generates a gradient magnetic field. The gradient drive unit 131 has three system drive circuits not shown in the drawing, corresponding to the three types of gradient coils in the gradient coil unit 105. The RF drive unit 141 applies a drive signal to the RF coil unit 33, transmits an RF excitation signal, and causes spin excitation within the body of the testee 31. The data acquisition unit 151 is input with the receive signal received by the RF coil unit 33, and collects these signals as digital data.

The seat drive section 111, gradient coil unit 131, RF drive unit 141 and the data acquisition unit 151 are controlled by the control unit 161. The section constituted by the magnet system 11, seat drive section 111, gradient coil unit 131, RF drive unit 141, data

acquisition unit 151 and the control unit 161 are an embodiment of the signal acquisition means of this invention.

The data processing unit 171 is input with signals output from the data acquisition unit 151. The data processing unit 171 stores data input from the data acquisition unit 151 into the memory not shown in the drawing.

The memory is internally comprised of data spaces. These data spaces are comprised of two-dimensional Fourier spaces. The data processing unit 171 performs two-dimensional inverse Fourier conversion of these two-dimensional Fourier spatial data and generates (reconstructs) a sectional layered image of the head of the testee 131.

The data processing unit 171 coordinates the processing in the control unit 161. The display unit 181 displays the reconstructed image output from the data processing unit 171 and information of various types. The operating unit 191 inputs commands and information of various types to the data processing unit 171 by user operation.

The section constituted by the magnet system 11, seat drive section 111, gradient coil unit 131, RF drive unit 141, data acquisition unit 151 control unit 161, data processing unit 171, display unit 181 and the operating unit 191 is an embodiment of the imaging device means of this invention.

FIG. 2 and FIG. 3 show an external view of the

testee 31 waiting in the magnet system 11. FIG. 2 is a perspective view and FIG. 3 is a side view showing a portion in cross section. As shown in these same figures, the magnet system 11 is supported by four support pillars 13 installed on the floor surface FL.

A pit 21 is made in the floor surface 50 below the magnet system 11. A stairs 51 are installed from the floor surface 50 downwards inside the pit 21. The seat 43 for seating the testee 31 is lowered by a seat up/down mechanism 41 to the bottom of the pit 21. The seat 43 and seat up/down mechanism 41 are made of nonmagnetic material.

A keyboard 45 such as for musical instruments is installed in front of the testee 31. The keyboard 45 is operated by the testee 31 during the imaging. The keyboard 45 is integrated into the seat. The keyboard operated by the testee 31 is not limited to a keyboard such as for musical instruments and may be a keyboard for information processors, or may be all types of equipment operated by hand such as tools, writing instruments or operating tools according to the subject of the test. Alternatively, equipment operated by the feed may be utilized according to the subject of the test.

One of the support pillars 13 is installed with an up/down switch 47. The up/down switch 47 forms a portion of the operating unit 191. Commands from the up/down switch 47 are applied to the seat drive section 111 by way of the control unit 161 and the data processing unit 171. The up/down switch 47 signal may also be directly applied to the seat drive section 111.

The seat drive section 111 raises and lower the seat 43 by means of the seat up/down mechanism 41 according to the commands that were input. In other words, the seat 43 is raised during imaging as shown in FIG. 4, and the testee 31 is carried along with the RF coil 33 into the imaging space and when the imaging is finished, the seat 43 is lowered to a standby (waiting) position as shown in FIG. 1 and FIG. 2.

The interrelation of the magnet system 11 and testee 31 and the RF coil 33 during imaging are shown in FIG. 5 along with the air feed device. The head of the testee 31 and the RF coil 33 as shown in the same figure, are positioned in the center of the magnet system 11 or in other words, the magnet center of the imaging range.

The rotating vanes 71 are installed facing the bore in the upper part of the magnet system 11. The rotating vanes 71 may for example have a structure the same as the rotating vanes of a blower fan, and rotate to send air (breeze) into the inner space of the magnet system 11. The rotating vanes 71 are an example of the embodiment of the rotating vanes of this invention.

A rotating force is applied to the rotating vanes 71 from the fluid motor 75 by way of a gear box 73. The fluid motor 75 has a rotator element or in other words, a water wheel (not shown in drawing) in the interior of the casing, and the water wheel rotates by being driven by fluid such as oil or water circulating by way of the piping 77. The circulation of the fluid is performed by a pump 79 installed at a position adequately separated from the magnet system 11.

The rotation of the water wheel is conveyed to the rotating vanes 71 by way of the gear box 73. The gears within the gear box 73 can be shifted to allow adjusting the rotational speed of the rotating vanes 71. Providing an internal clutch for turning the gears on and off allows intermittently conveying the motive force from the liquid motor 75 to the rotating vanes 71.

The control unit 161 is control the shifting of gears and turning the clutch on and off. Needless to say, this control may be performed manually. The gear box 73 may be omitted when there is no need to adjust the rotational speed of the rotating vanes 71.

The rotating vanes 71, the gear box 73 and the fluid motor 75 are made of a nonmetallic material such as ceramic or plastic. The piping 77 may also be made of a nonmetallic material. The piping 77 may also be made of rubber.

In an air feed device of this type, since the fluid motor 75 uses no electricity, no magnetic signals are generated and interfere with the magnetic resonance signal might not occur. Also, the gear box 73, the fluid motor 75 and the rotating vanes 71 are made of a nonmetallic and nonmagnetic material such as plastic or ceramics so that the operation of these components does not disturb the electrical environment of the magnet system 11.

These components can be installed very near to the bore (inner space) entrance of the magnet system 11. Alternatively these components can also be installed in the inner space of the magnet system 11 if required. An

installation of this type allows sending air with no losses or in other words sending an air blow (breeze) with high efficiency.

Adjustment of the rotational speed of the rotating vane 71 may also be made to adjust the flow rate of the fluid in the control valve 81 installed in the piping 77 as shown in FIG. 6. The flow rate adjuster valve 81 is an example of the embodiment of the adjustment means of this invention. The flow rate adjuster valve 81 is also made of antimagnetic and nonmetallic material however this may not be required if installed a sufficient distance away from the magnet system 11.

The air flow rate adjustment by the flow rate adjuster valve 81 is performed automatically by the control unit 161 or manually adjusted by the operator. Alternatively, the air flow may also be adjusted by manually or automatically controlling the rotational speed of the pump 79 without using the flow rate adjuster valve 81. Further, needless to say, a joint adjustment by the flow rate adjuster valve 81 and adjustment of the pump 79 may also be employed.

The air flow rate adjustment may also be performed by adjusting the flow rate supplied to the pipe passage 83 and flow rate supplied to the fluid motor 75 by means of the flow rate adjuster valve 81 installed in the pipe passage 83 bypassing the fluid motor 75 as shown in FIG. 7. The flow rate adjuster valve 81 is an example of the embodiment of the adjustment means of this invention.

When the main magnetic field coil unit of the magnet system 11 is constituted of an ordinary conductive coil,

the cooling of the ordinary conductive coil is performed by fluid to suppress the rise in temperature due to heat emitted by the ordinary conductive coil. Even if a superconductive coil is used, cooling by fluid is likely to be performed, when suppressing a rise in temperature is necessary in the gradient coil unit. When the magnet system 11 has such a liquid cooling device, the flow movement of the cooling liquid may also be utilized to turn the fluid motor 75.

In other words, when the interior of the magnet system 11 has a section for cooling such as a gradient coil unit or main magnetic field coil unit cooled by fluid made to circulate by a pump 79 while heat is emitted by the radiator 85, then the fluid motor 75 is installed in the flow path of the circulating fluid. Such an arrangement allows simplifying the structure by integrating the cooling system and the fluid motor drive system.

In such a structure, the air flow rate is appropriately adjusted by turning the clutch on and off and shifting the gears in the gear box 73. So there is therefore no change in the flow rate of the fluid even if the air flow rate is adjusted, and the air flow rate can be adjusted without affecting the cooling performance.

Alternatively, the air flow rate can be adjusted to an appropriate figure as shown in FIG. 9, by adjusting the ratio of the fluid flow flowing in the fluid motor 75 to the fluid flowing in the pipe passage 83 by means of the fluid motor 75 in the cooling fluid circulation path, the pipe passage 83 bypassing the fluid motor 75, and the

flow rate adjuster valve 81 installed in the pipe passage 83. The overall flow rate quantity does not change even if this fluid flow ratio is adjusted, so the air flow rate can be adjusted without affecting the cooling performance.

The operation of this device is described next. The operator 35 first of all, seats the testee 31 in the seat 43 lowered inside the pit 21, so the head of the test subject 31 is within the RF coil 33. The operator 35 next operates the switch 47 to operate the seat up/down mechanism 41, and raise the seat 43 to the imaging position shown in FIG. 5.

In this state, the fluid motor 75 operates, sending air (breeze) to the inner space of the magnet system 11. This air blow is performed intermittently while the testee 31 is present in the inner space. The testee 31 can therefore feel a pleasant cooling sensation even within the narrow inner space.

The operator 35 next operates the operating unit 191 to start the imaging. The imaging proceeds under the control of the control unit 161. A typical pulse sequence utilized in the magnetic resonance imaging is shown in FIG. 10. This pulse sequence is an SE pulse sequence produced by the spin echo method.

In other words, (1) is an RF excitation 90 degree pulse and 180 degree pulse sequence by the SE method. In the same way, (2), (3), and (4) are respectively the slice gradient Gs, the readout gradient Gr, the phase encode gradient Gp and the spin echo MR sequences. The 90 degree pulse and 180 degree pulse respectively represent

the center signals. The pulse sequence proceeds from left to right along the time axis t.

The 90 degree spin excitation is performed by the 90 degree pulse as shown in the same figure. The excitation selected for the specified slice applied with the slice gradient Gs is performed at this time. After 90 degree excitation at the specified time, 180 degree excitation by the 180 degree pulse or in other words, an inverted spin is performed. The slice gradient GS is also applied at this time, and selective inversion of the same slice is performed.

As shown in the same figure, the readout gradient Gr and the phase encode gradient Gp are applied in the period of 90 degree excitation and spin inversion. Spin dephasing is performed by the readout gradient Gr. Spin phase encoding is performed by the phase encode gradient Gp.

After spin inversion, the spin is rephased by the readout gradient Gr, and the spin echo MR generated. The spin echo MR is an RF signal having a waveform symmetrical to the center echo. The center echo occurs at a point in time after TE (echo time) from the 90 degree excitation. The spin echo MR is collected as view data by the data acquisition unit 151. A pulse sequence of this kind is repeated 64 to 512 times at the periodic TR (repetition time). The phase encode gradient GP is changed each time the pulse sequence is repeated, and different phase encoding performed each time. View data for views 64 to 512 are acquired in this way.

Another magnetic resonance imaging pulse sequence is

shown in FIG. 11. This pulse sequence is a GRE (gradient echo pulse) produced by the gradient echo method.

In other words, in the figure, (1) is the RF excitation αpulse sequence in the GRE method. Also, (2), (3) and (4) are respectively, the slice gradient Gs, the readout gradient Gr, the phase encode gradient Gp and the gradient echo MR sequences. The αpulse represents the center signal. The pulse sequence proceeds from left to right along the time axis t.

The spinαexcitation by theαpulse is therefore performed as shown in FIG. 11. Here, αis less than 90 degrees. The excitation selected for the specified slice applied with the slice gradient Gs is performed at this time.

After αexcitation, spin phase decoding is performed by the phase encode gradient Gp. Next, the spin is first dephased by the readout gradient Gr, the spin then rephased, and a gradient echo MR generated. The gradient echo MR is an RF signal having a waveform symmetrical with the echo center. the center occurs at a point in time after echo time TE from the αexcitation.

The gradient echo MR is collected as view data by the data acquisition unit 151. A pulse sequence of this kind is repeated 64 to 512 times at a period TR (repetition time). The phase encode gradient GP is changed each time the pulse sequence is repeated, and different phase encoding performed each time. View data for views 64 to 512 are obtained in this way.

The view data acquired by means of the pulse

sequences of FIG. 10 or FIG. 11 are collected in the memory of the data processing unit 171. The pulse sequence utilized in the imaging is not limited to the GRE method or the SE method and other methods such as FSE (Fast Spin Echo), and EPI (Echo Planar Imaging) may also be utilized as needed.

The data processing unit 171 performs two-dimensional inverse Fourier transforming of the view data and reconstructs a stepped image of the head of the testee 31. The reconstructed image is displayed as a viewable image on the display unit 181.

The brain functions of the testee 31 are examined based on the images acquired by imaging of the testee 31 while carrying out a specified keyboard operation. The keyboard operation is performed while the testee 31 is in an upright position so that the device is operated while the testee 31 is in the same state as a normally active human being. The imaging of brain functions can therefore be correctly performed while the testee 31 is in a normal active state.

Besides imaging the testee 31 while performing a task with his hands, imaging can be performed of the state of the brain for instance while the testee 31 is speaking a word, singing or remembering a thought, and the brain functions during routine activities can be correctly imaged. Imaging of brain behavior when sensory functions such as hearing, taste, smell, or feel are being stimulated can also be performed in the same way.

The example of a magnet system described above is for a vertical bore magnet system, however this invention

is not limited to a vertical bore magnet system and a magnetic resonance imaging device utilizing a horizontal bore magnet system with the bore facing horizontally may also be installed in an air feed device as described above.

Examples of the structure of the magnet system section in a magnetic resonance imaging device of this kind are respectively shown in FIG. 12, FIG. 13, FIG. 14, FIG. 15 and FIG. 16. Of the figures, those sections the same as shown in FIG. 5, FIG. 6, FIG. 7, FIG. 8 and FIG. 9 have the same reference numerals so an explanation is omitted here.

FIG. 12 shows a horizontal bore magnet system installed with an air feed device the same as shown in FIG. 5. In the same way, the horizontal bore magnet systems of FIG. 13, FIG. 14, FIG. 15 and FIG. 16 are respectively installed with air feed device the same as shown in FIG. 6, FIG. 7, FIG. 8 and FIG. 9.

The inner space of the magnet system 11 as shown in these figures, is a columnar inner space having a horizontal center axis. The testee 31 is carried in and carried out of the inner space of the magnet system 11 mounted on a support plate 91. The RF coil 33 is attached to the support plate 91. Air is fed into this inner space by rotation of the rotating vanes 71 by means of the fluid motor 75.

The above imaging device was described for this invention with a magnetic resonance imaging device however the imaging device of this invention is not limited to use in a magnetic resonance imaging device and

may utilize a signal acquisition device having a space to hold the imaging subject such as PET (positron emission tomography, gamma cameras (γ camera), X-ray CT(Computed tomography) and other types of imaging devices may also be utilized.

Many widely different embodiments of the invention may be configured without departing from the spirit and the scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

Claims:

1. An air feed device comprising:

a fluid motor rotating by fluid flow; and

rotating vanes driven by the fluid motor and forcing air into a space accommodating a subject.

2. The air feed device of claim 1, further comprising:

adjustment means for adjusting fluid flow quantity supplied to the fluid motor.

3. The air feed device of claim 1, further comprising:

adjustment means for adjusting ratio of fluid flow quantity supplied to the fluid motor to fluid flow quantity bypassing the fluid motor.

4. A signal acquisition device comprising:

signal acquisition means including a space accommodating a subject for imaging;

a fluid motor rotating by fluid flow; and

rotating vanes driven by the fluid motor and forcing air into the space.

5. The signal acquisition device of claim 4, further comprising:

adjustment means for adjusting fluid flow quantity supplied to the fluid motor.

6. The signal acquisition device of claim 4, further comprising:

adjustment means for adjusting ratio of fluid flow quantity supplied to the fluid motor to fluid flow quantity bypassing the fluid motor.

7. The signal acquisition device of claim 4, wherein the signal acquisition means has a section to be cooled by fluid, and the fluid motor is driven by fluid to cool the section.

8. The signal acquisition device of claim 4, wherein the signal acquisition means acquires magnetic resonance signal.

9. The signal acquisition device of claim 4, wherein the rotating vanes and the fluid motor are made of nonmagnetic material or nonmetallic material.

10. An imaging device comprising:

imaging means including a space accommodating a subject for imaging;

a fluid motor rotating by flow of fluid; and

rotating vanes driven by the fluid motor and forcing air into the space.

11. The imaging device of claim 10, further comprising:

adjustment means for adjusting fluid flow quantity supplied to the fluid motor.

12. The imaging device of claim 10, further comprising:

adjustment means for adjusting ratio of fluid flow quantity supplied to the fluid motor to fluid flow quantity bypassing the fluid motor.

13. The imaging device of claim 10, wherein the imaging means has a section to be cooled by fluid, and the fluid motor is driven by fluid to cool the section.

14. The imaging device of claim 10, wherein the imaging means produces an image by utilizing magnetic resonance imaging.

15. The imaging device of claim 10, wherein the

rotating vanes and the fluid motor are made of nonmagnetic material or nonmetallic material.

FIG. 1

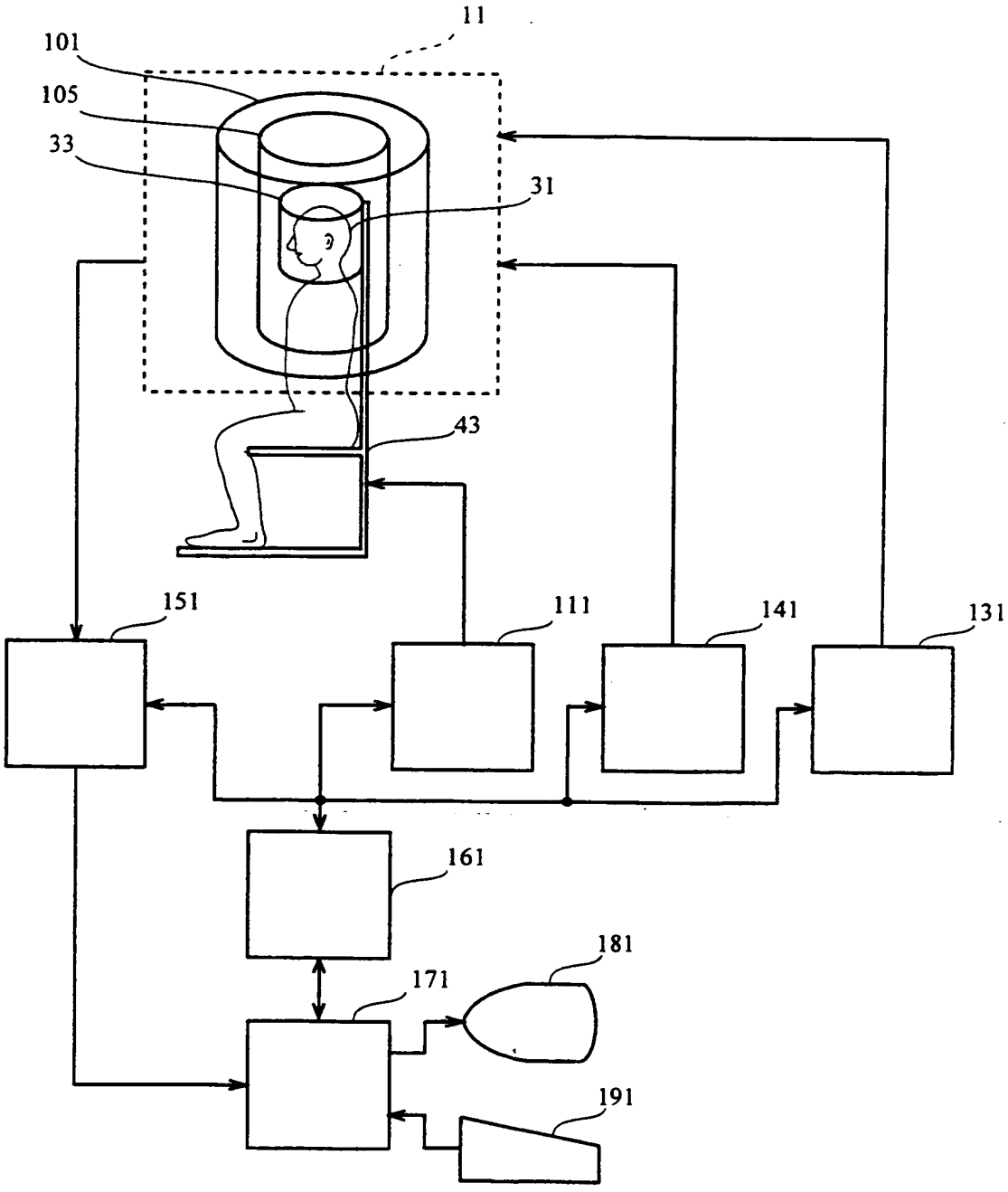


FIG. 2

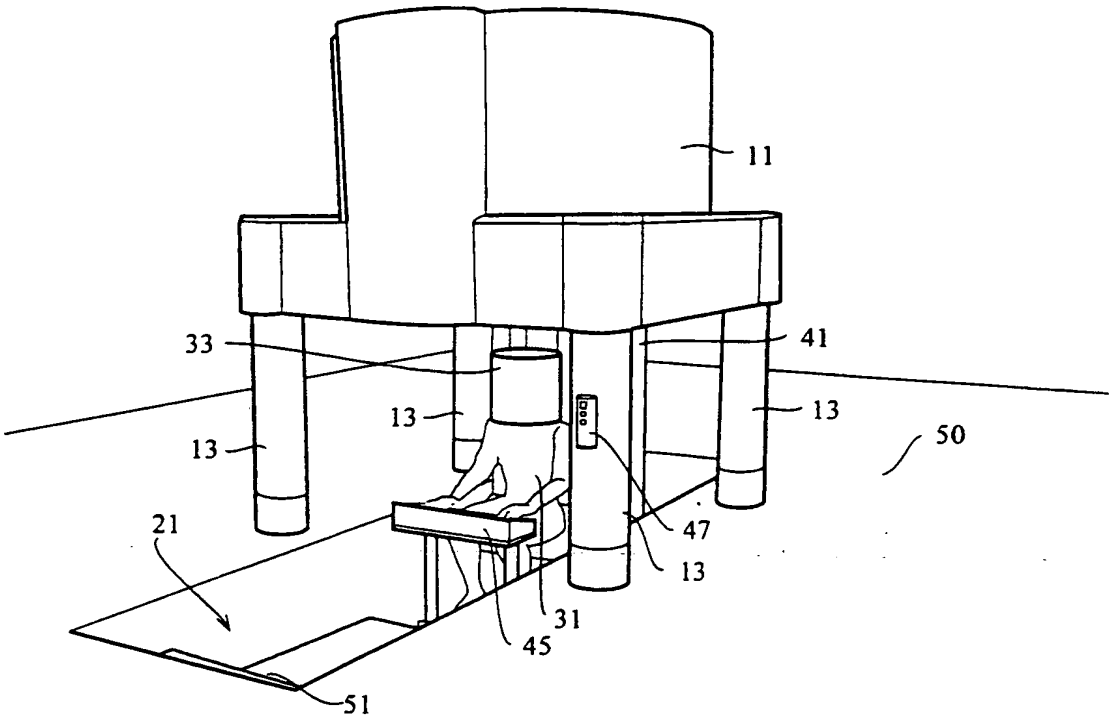


FIG. 3

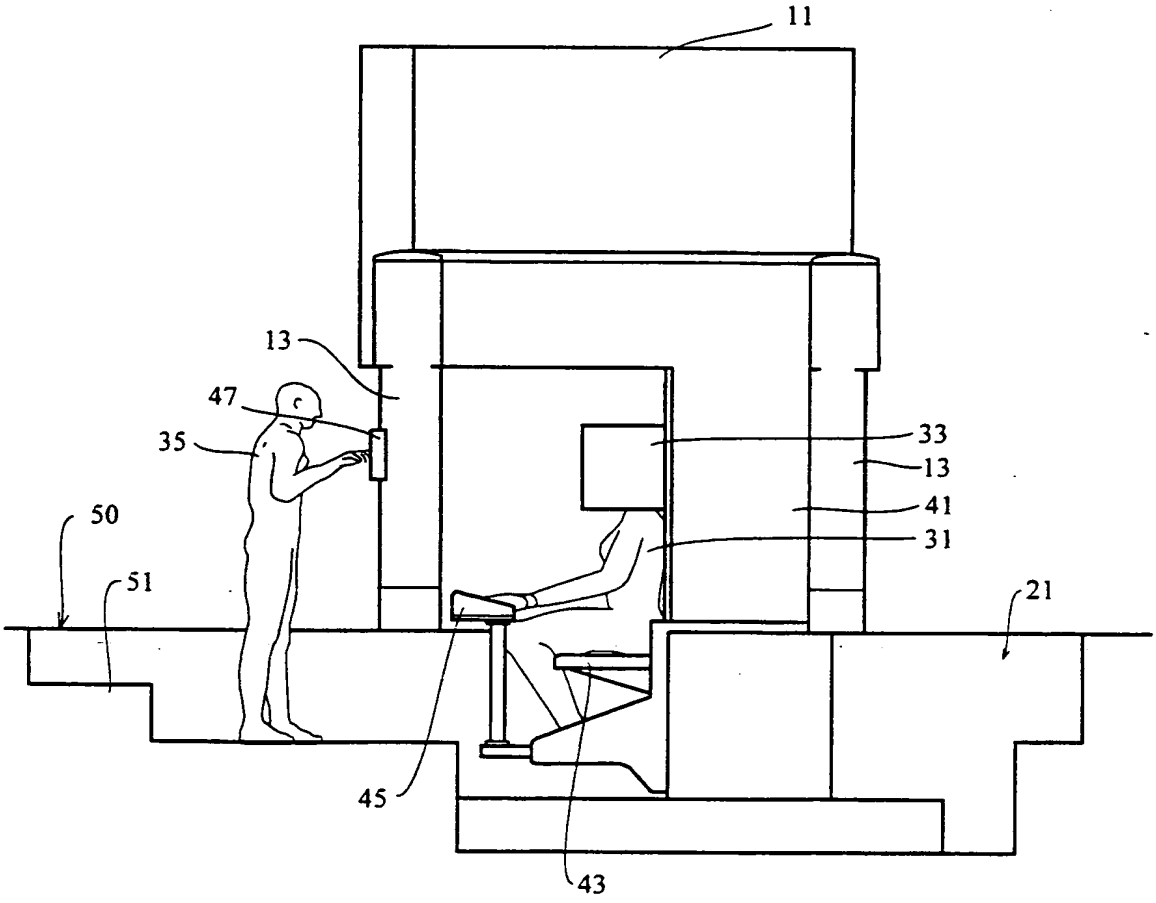


FIG. 4

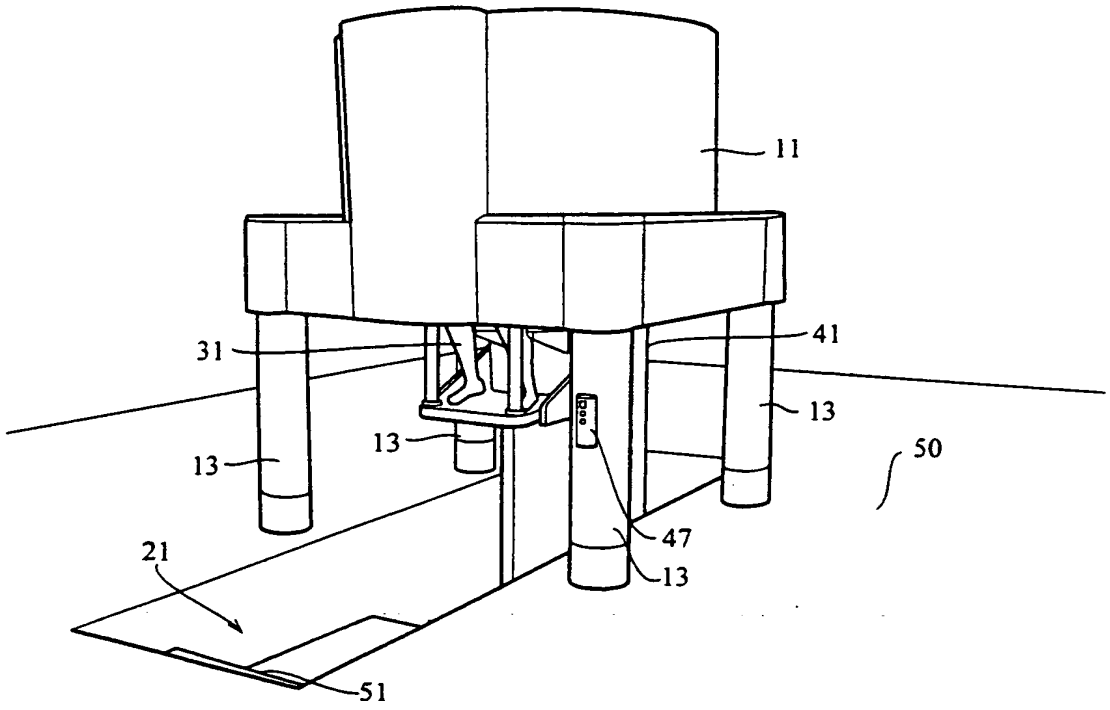


FIG. 5

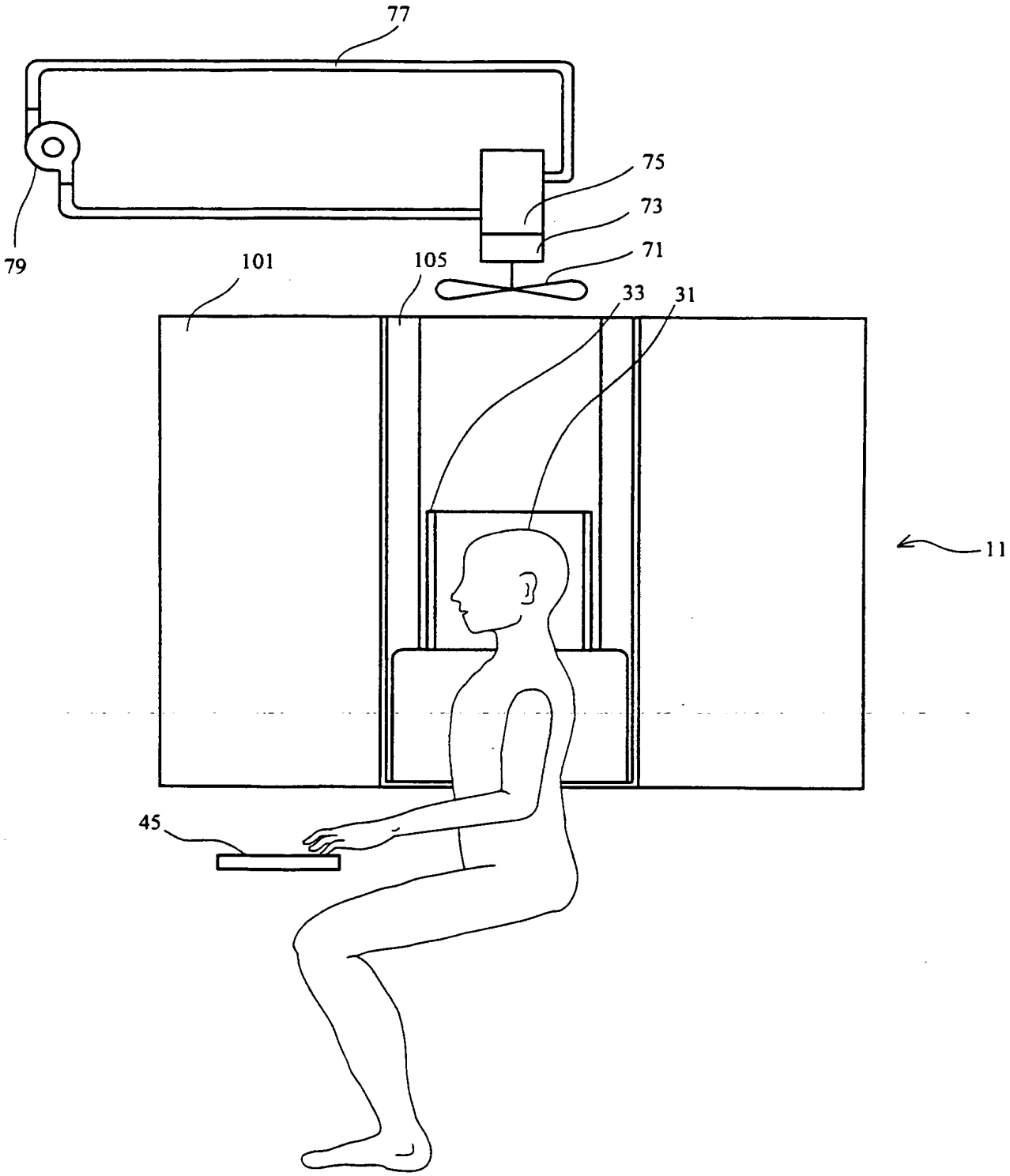


FIG. 6

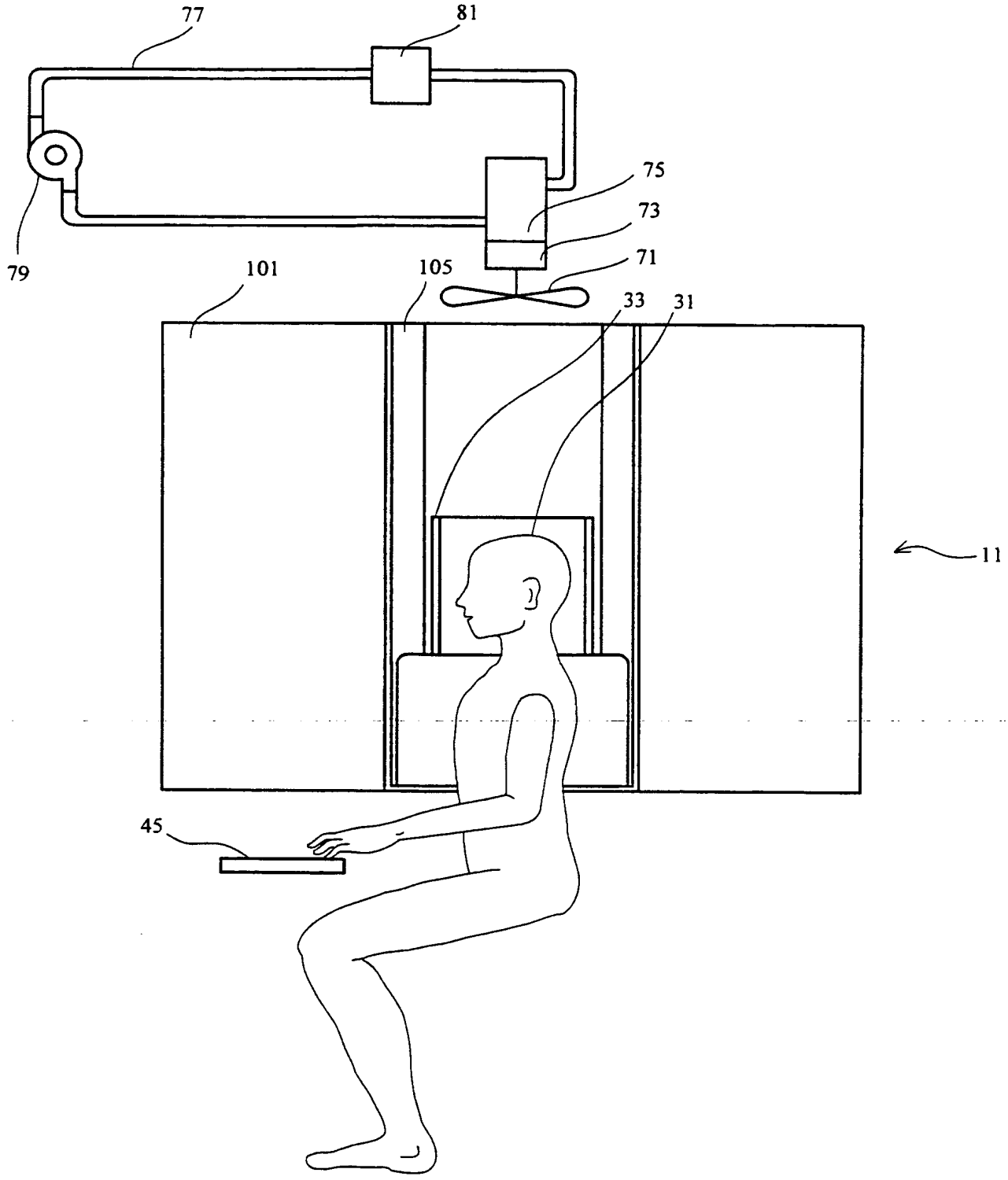


FIG. 7

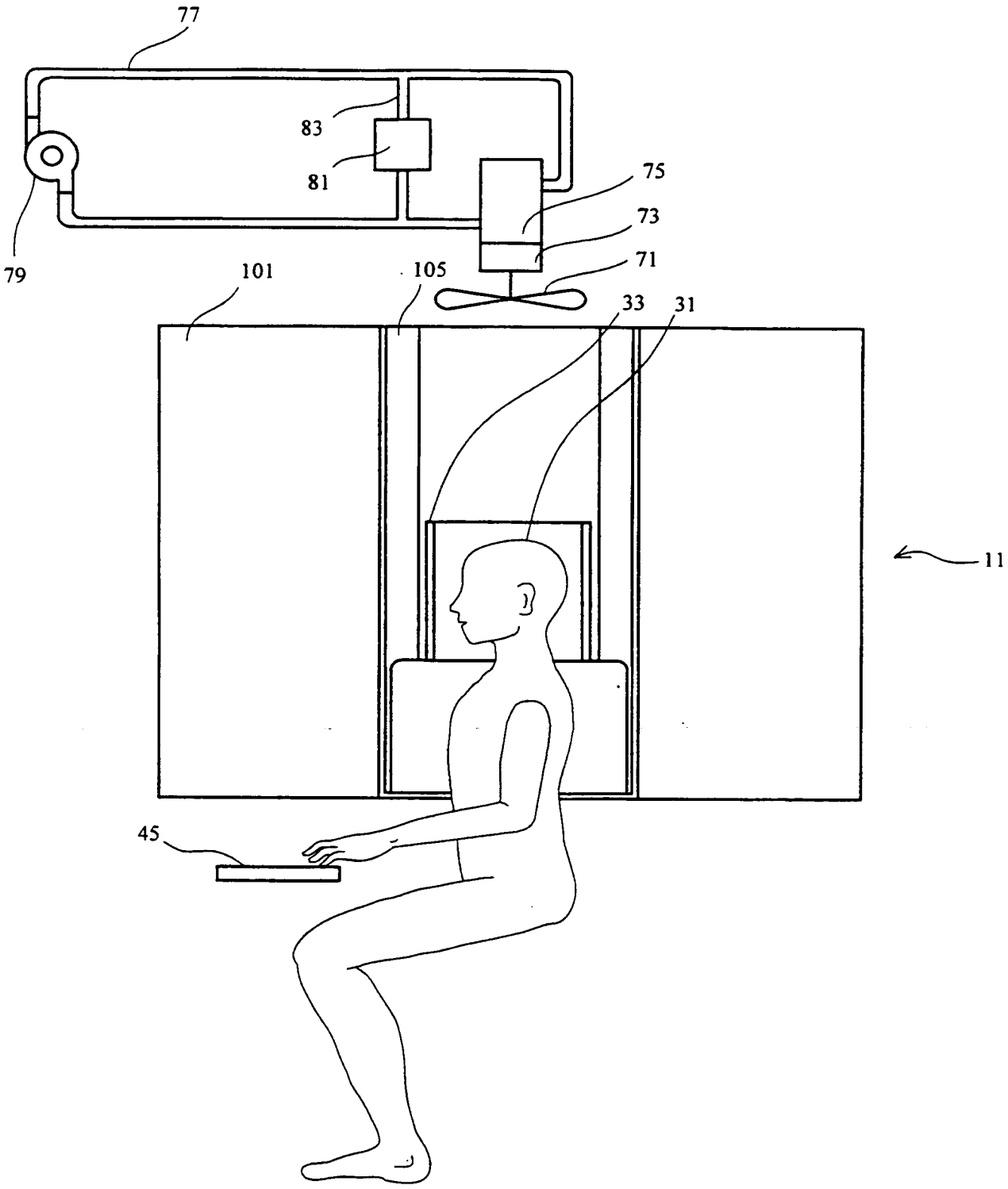


FIG. 8

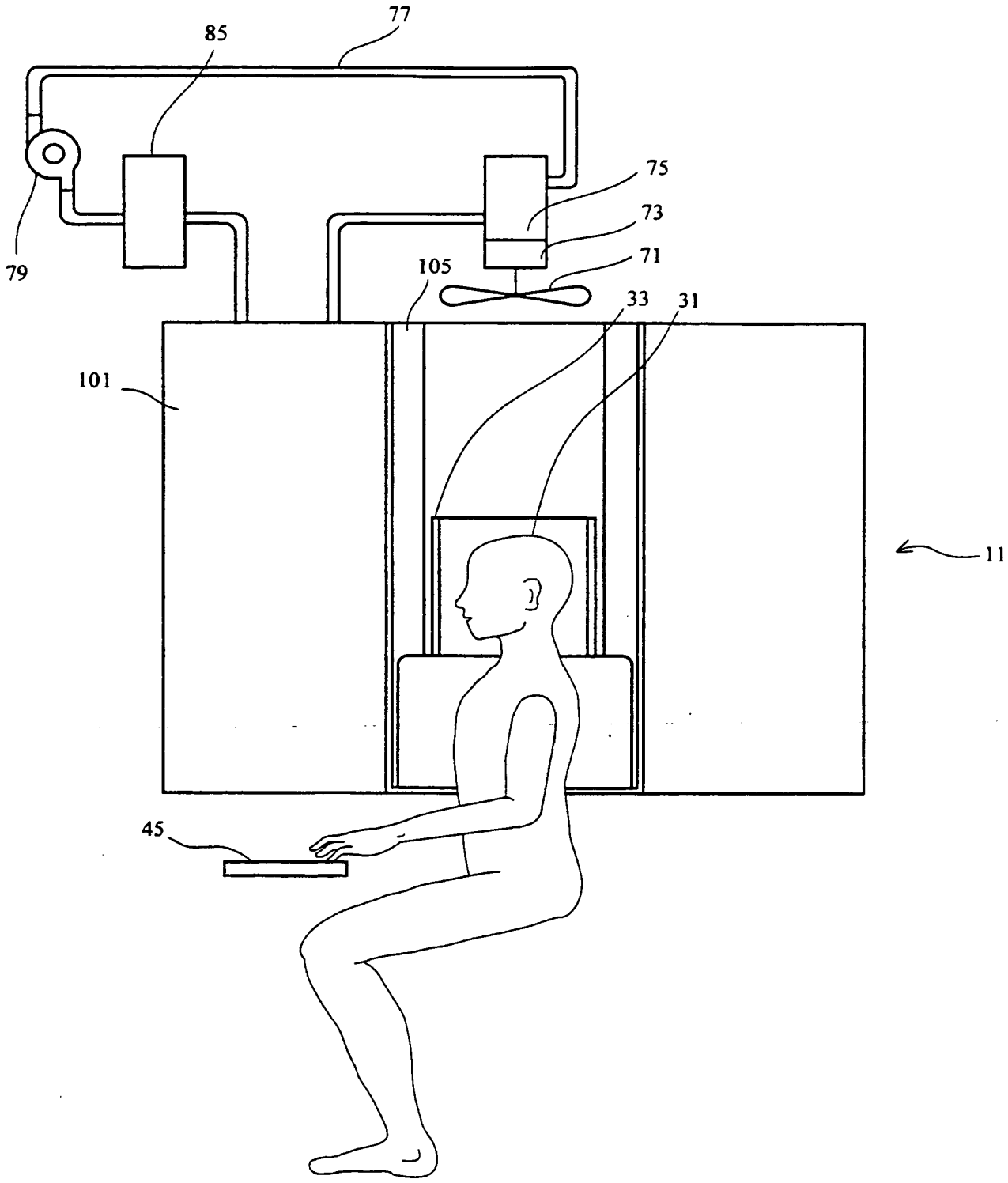
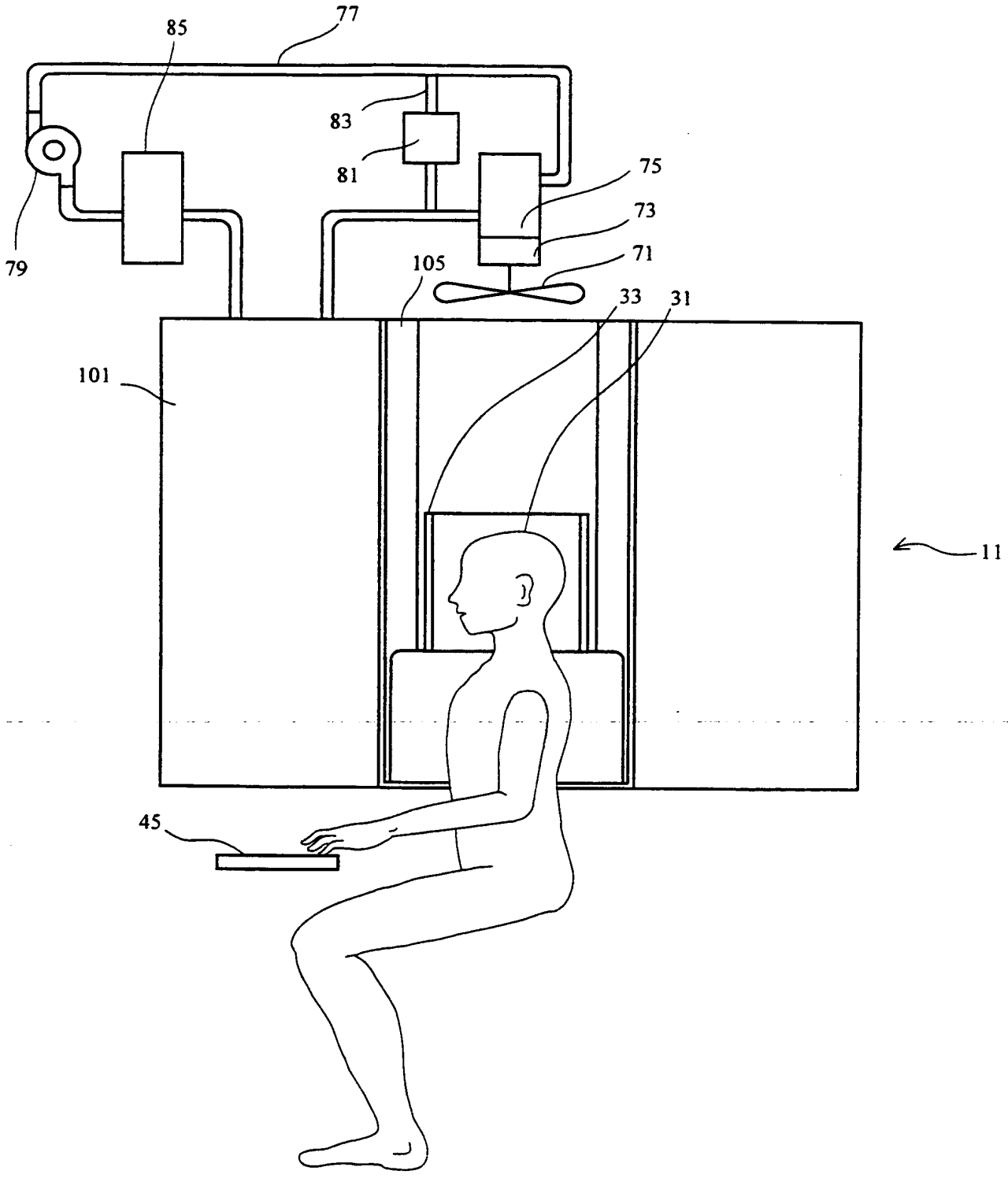


FIG. 9 9/16



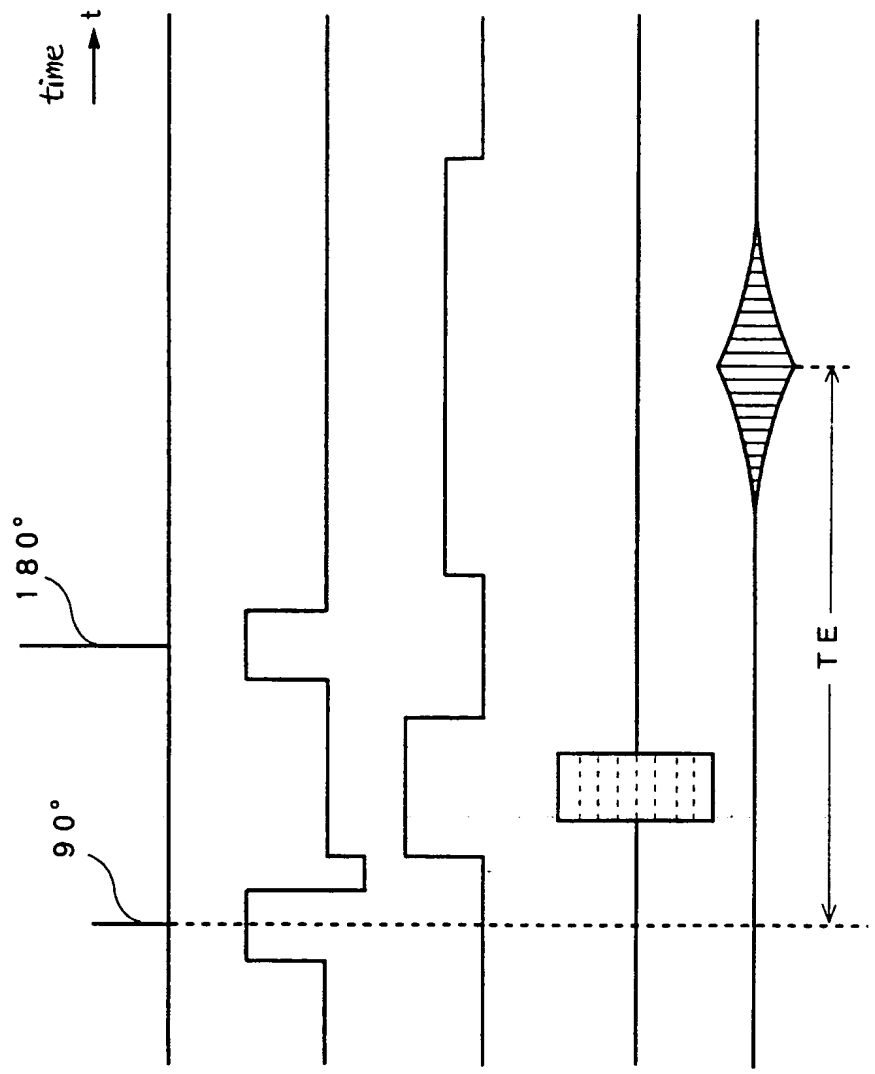


FIG.10

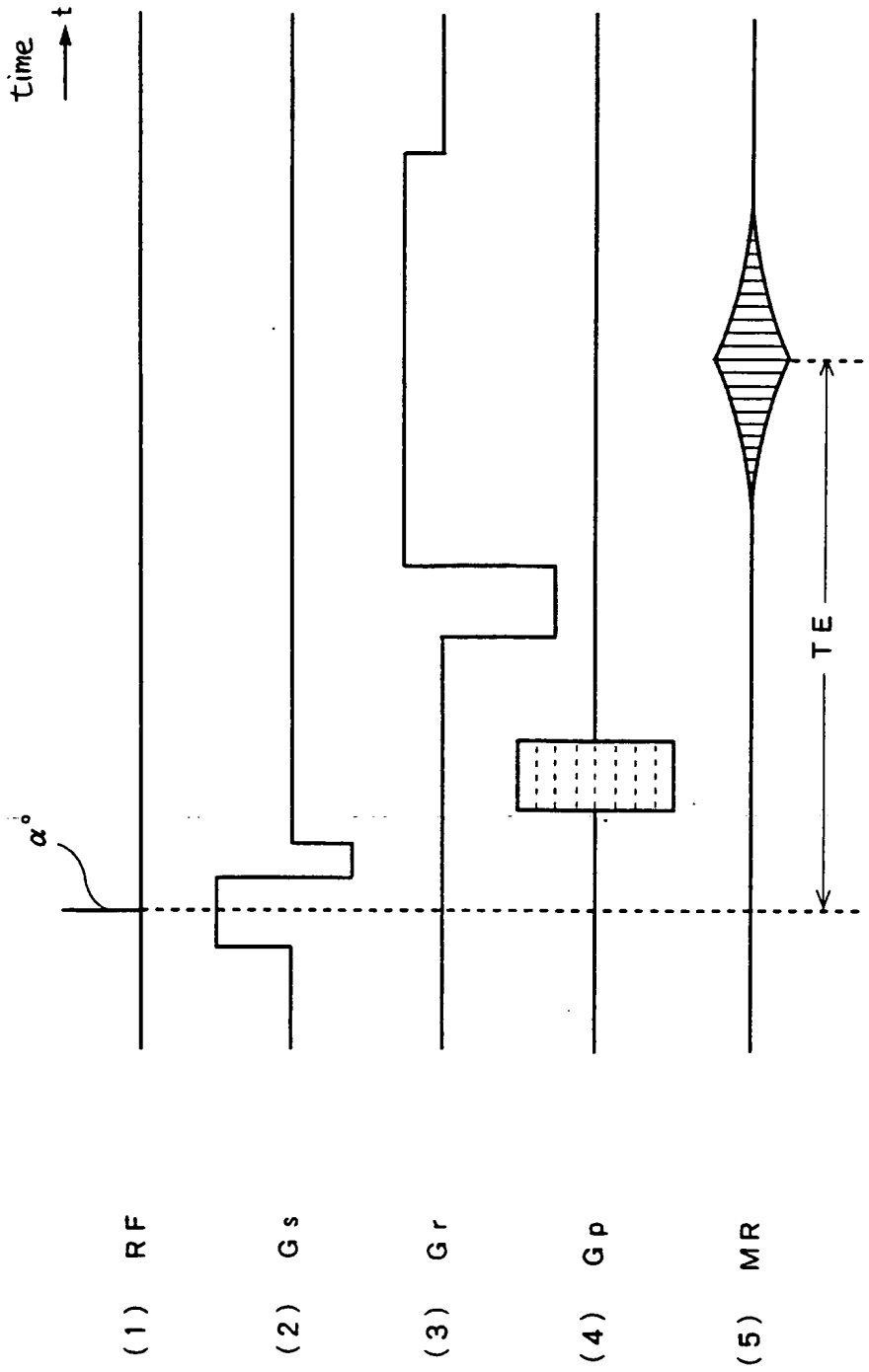


FIG.11

FIG. 12

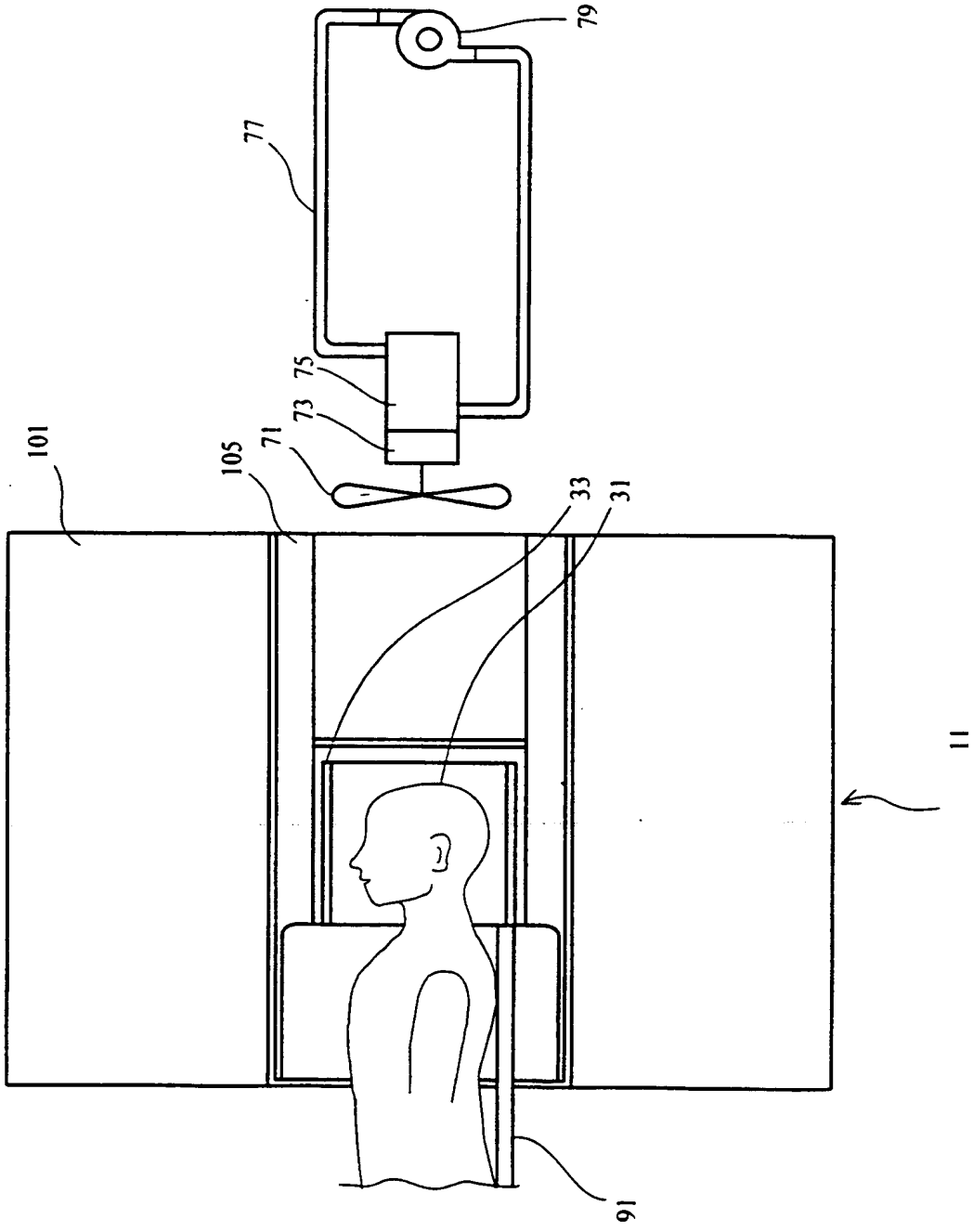


FIG. 13

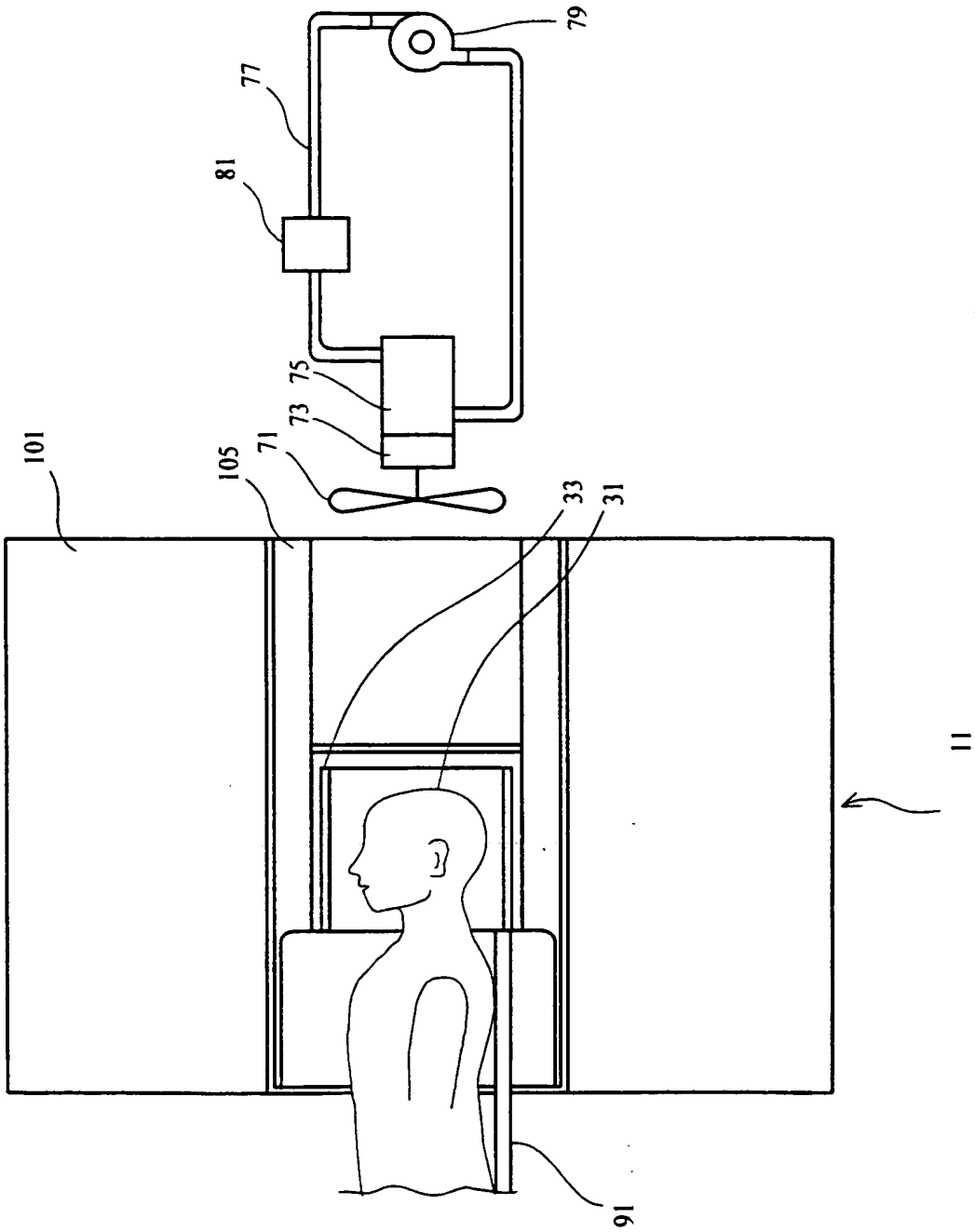


FIG. 14

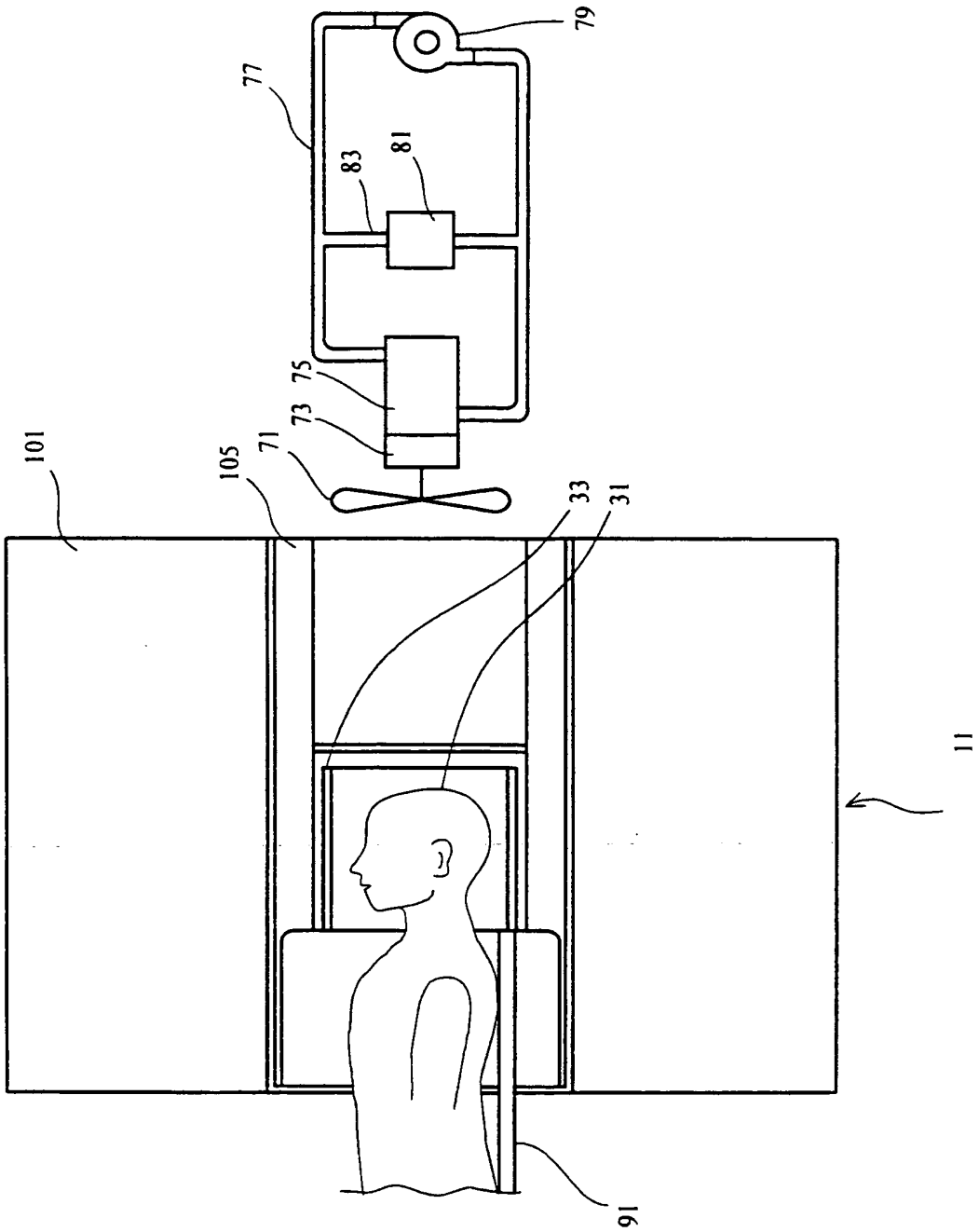


FIG. 15

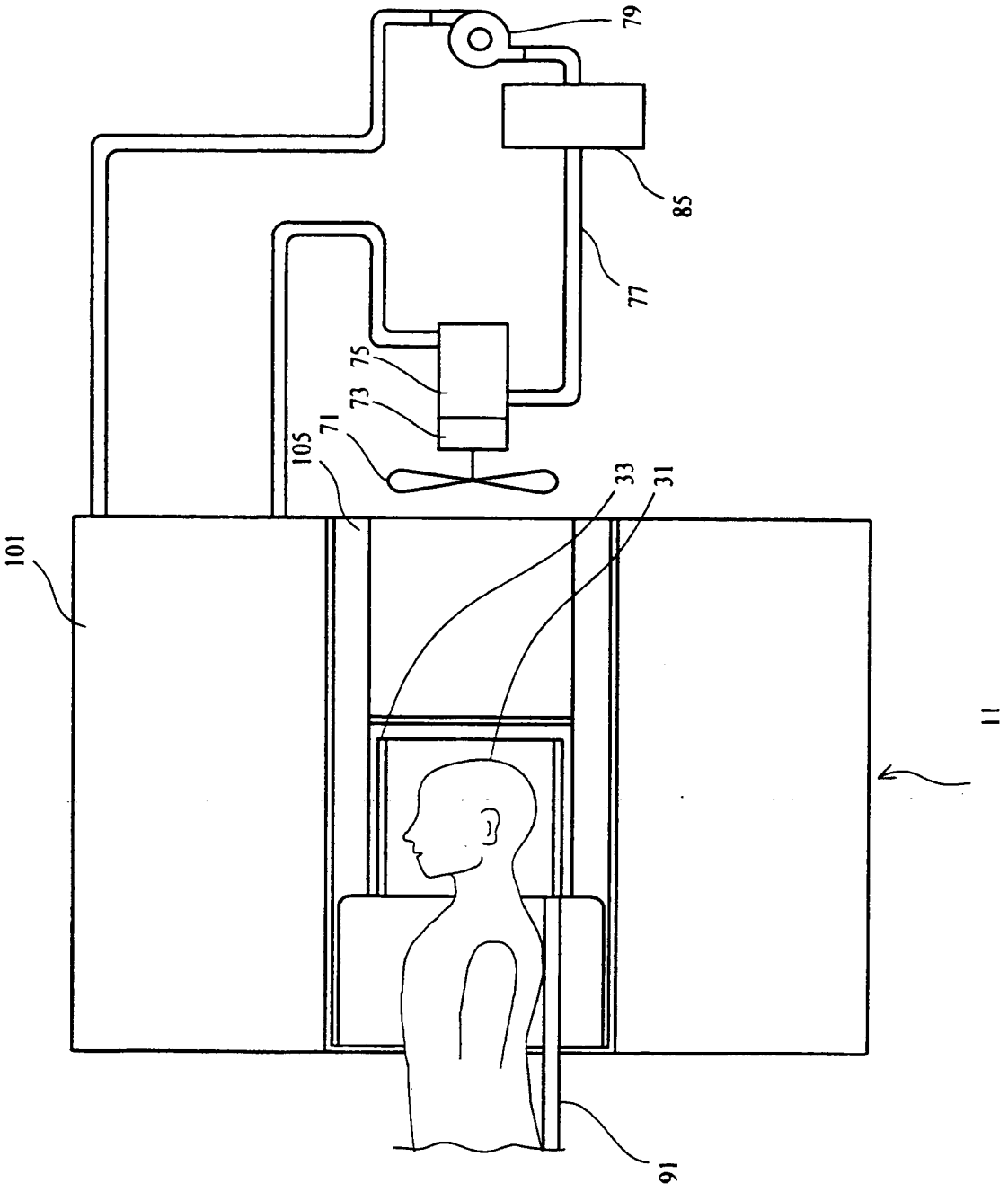


FIG. 16